UNIVERSITI SAINS MALAYSIA

Final Examination
Academic Session 2008/2009

April 2009

JIF 217 – Electricity and Magnetism
[JIF 217 – Keelektrikan dan Kemagnetan]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **ELEVEN** printed pages before you begin the examination.

Answer **ALL** questions. You may answer **either** in Bahasa Malaysia or in English.

Read the instructions carefully before answering.

Each question carries 20 marks.

*Sila pastikan kertas peperiksaan ini mengandungi **SEBELAS** muka surat yang bercetak sebelum anda menjawab sebarang soalan.*

*Jawab **SEMUA** soalan. Anda dibenarkan menjawab soalan **sama ada** dalam Bahasa Malaysia atau Bahasa Inggeris.*

Baca setiap arahan dengan teliti sebelum menjawab.

Setiap soalan diperuntukkan 20 markah.

...2/-

Constants:

Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

1 Pa = 1 N m^{-2}

1 atm = 1.013×10^5 Pa

Molar gas constant $R = 8.31$ J mol^{-1} K^{-1}

Permeability constant $\mu_o = 4\pi \times 10^{-7}$ wb A^{-1} m^{-1} (or H m^{-1})

Permittivity constant $\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}

Planck's constant $h = 6.6 \times 10^{-34}$ J s

$c = 3 \times 10^8$ m s^{-1}

1 eV = 1.60×10^{-19} J

Electron rest-mass $m_e = 9.11 \times 10^{-31}$ kg

Mass of proton = 1.007276 amu

Mass of neutron = 1.008665 amu

Avogadro's number = 6.022×10^{23} mol^{-1}

1 amu = 1.66×10^{-27} kg = 931 MeV

...3/-

1. (a) Write down the equation of the Coulomb's force acting on one of two point charges, q_1 and q_2, in a vector form. Explain the meaning of the subscripts of the vectors and the unit vectors.

(8 marks)

(b) Figure 1 shows two point charges at the corners of a square. Given that $q = 1.0 \times 10^{-8}$ C and $a = 5.0$ cm. Determine

(i) the magnitude and the direction of the force acting on the point charge $+q$,

(ii) the magnitude and the direction of the electric field at the center of the square.

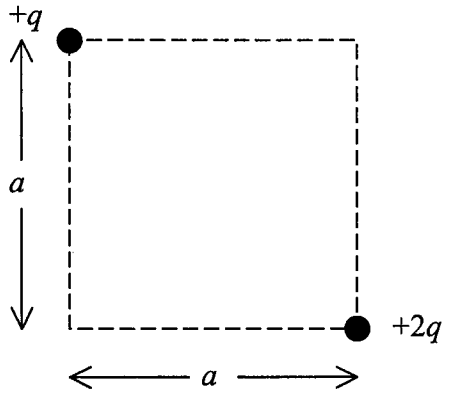

Figure 1

(12 marks)

2. (a) Explain the Gauss' law in words, equation and suitable diagrams. Explain its usage.

(8 marks)

(b) A thin metallic sphere has a radius a and is carrying charge q_a. An identical concentric sphere has a radius b ($b > a$) and is carrying charge q_b. Use Gauss' Law to determine the electric field E at the radial points r where

(i) $r < a$,

(ii) $a < r < b$.

(12 marks)

3. (a) Define Kirchoff's Laws.

(6 marks)

(b) Determine the current passing through the resistor $2R$ in terms of ε and R as shown in Figure 2. Assume ammeter A has no internal resistance.

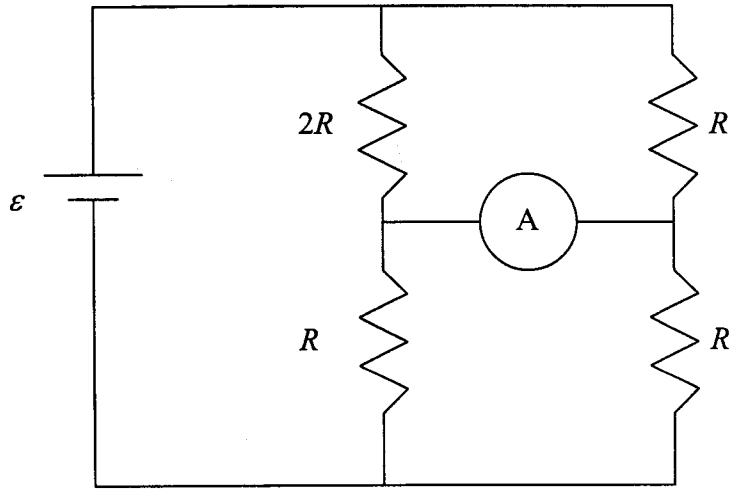

Figure 2

(14 marks)

4. (a) Explain Ampere's Law. Write down the Ampere's Law equation for an infinite long conductor wire and explain the meaning of the symbols used.

(6 marks)

(b)

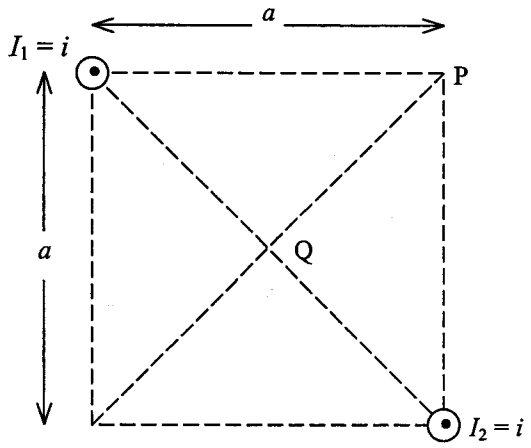

Figure 3

Figure 3 shows two infinite long wires each carrying a current i. Both conductors are parallel to each other and are perpendicular to the plane of the paper. Given that $a = 2$ cm and $i = 2$ A. Calculate

(i) the magnitude and the direction of the magnetic field on I_1 due to conductor I_2,

(ii) the magnitude and the direction of the force acting on conductor I_1.

(14 marks)

...6/-

5. (a) In some books, Lenz's law is stated as: "The direction of an induced current is such as to oppose the cause producing it." Using appropriate diagrams, explain what it means.

(8 marks)

(b) A solenoid having an inductance 5 μH is connected in series with a 2 kΩ resistor. At time $t = 0$, a 12 V battery is connected across them.

(i) Determine the inductive time constant τ_L.

(ii) How long will it take for the current through the resistor to reach 90% of its final value?

(iii) If the number of turns per unit length of the solenoid is 20 turns per mm, calculate the magnitude of B in the solenoid after the current has reached its equilibrium value.

(12 marks)

...7/-

Pemalar-pemalar:

Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

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...8/-

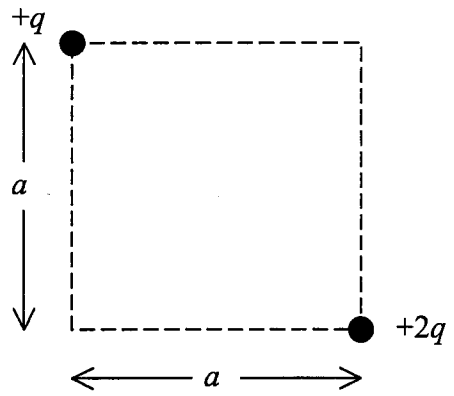
1. (a) *Tuliskan persamaan daya Coulomb yang bertindak pada salah satu daripada dua cas titik, q_1 dan q_2, dalam bentuk vektor. Jelaskan maksud subskrip vektor dan subskrip vektor unit.*

(8 markah)

(b) *Rajah 1 menunjukkan dua cas titik pada penjuru suatu segiempat sama. Diberikan $q = 1.0 \times 10^{-8}$ C dan $a = 5.0$ cm. Tentukan*

(i) *magnitud dan arah daya yang bertindak pada cas titik +q,*

(ii) *magnitud dan arah medan elektrik di pusat segiempat tersebut.*



Rajah 1

(12 markah)

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2. (a) *Jelaskan hukum Gauss dengan perkataan, persamaan dan rajah yang sesuai. Jelaskan juga penggunaannya.*

(8 markah)

(b) *Suatu sfera logam nipis mempunyai jejari a dan membawa cas q_a. Suatu sfera sepusat seiras mempunyai jejari b ($b > a$) dan membawa cas q_b. Gunakan hukum Gauss untuk menentukan medan elektrik E pada titik-titik jejarian r berikut*

(i) $r < a$,

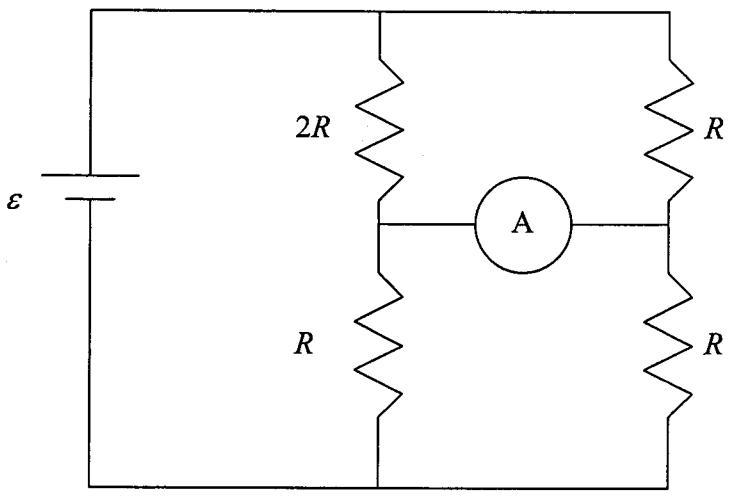
(ii) $a < r < b$.

(12 markah)

3. (a) *Takrifkan hukum Kirchoff.*

(6 markah)

(b) *Tentukan arus yang melalui perintang 2R dalam sebutan ε dan R seperti yang ditunjukkan dalam Rajah 2. Andaikan ammeter A tidak mempunyai rintangan dalaman.*



Rajah 2

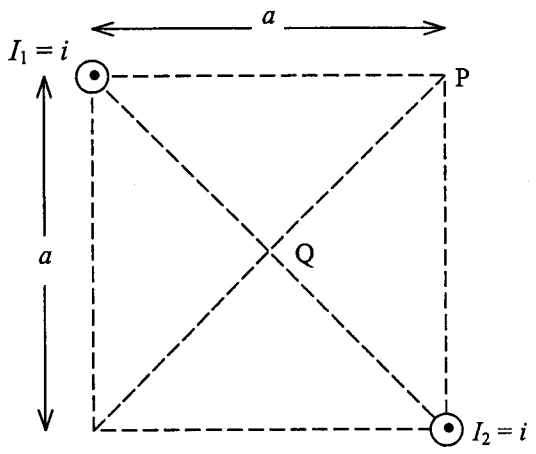
(14 markah)

...10/-

4. (a) *Jelaskan hukum Ampere. Tuliskan persamaan hukum Ampere bagi suatu dawai konduktor panjang tak terhingga dan jelaskan maksud simbol-simbol yang digunakan.*

(6 markah)

(b)



Rajah 3

Rajah 3 menunjukkan dua dawai panjang tak terhingga setiap satu membawa arus i. Kedua-dua konduktor adalah selari dan serenjang kepada satah kertas. Diberikan a = 2 cm dan i = 2 A. Hitung

(i) magnitud dan arah medan magnet pada I_1 disebabkan oleh konduktor I_2,

(ii) magnitud dan arah daya yang bertindak pada konduktor I_1.

(14 markah)

...11/-

5. (a) *Dalam sesetengah buku, hukum Lenz dinyatakan sebagai: "Arah arus teraruh adalah sedemikian ia menentang asbab yang menghasilkannya." Dengan menggunakan gambarajah yang sesuai, jelaskan maksud pernyataan ini.*

(8 markah)

(b) *Suatu solenoid mempunyai induktans 5 μH disambungkan secara siri dengan suatu perintang 2 kΩ. Pada masa t = 0, satu bateri 12 V disambungkan merentasi kedua-duanya.*

(i) *Tentukan pemalar masa induktif* τ_L.

(ii) *Berapa lamakah masa yang diambil oleh arus untuk mencapai 90% nilai akhirnya?*

(iii) *Jika bilangan lilitan seunit panjang solenoid ialah 20 lilitan per mm, hitung magnitud B dalam solenoid selepas arus mencapai nilai keseimbangan.*

(12 markah)

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